Improvement in Jet Aircraft Operation with the Use of High-Performance Drop-in Fuels

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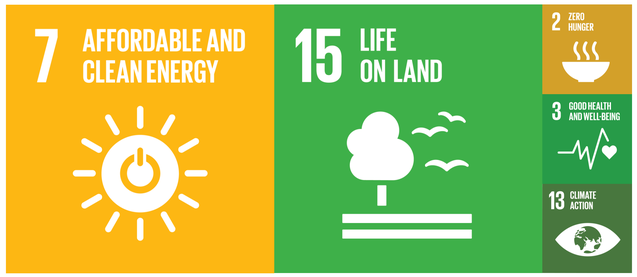
Research Objective: To bound the economic and environmental benefits that can be achieved using high performance jet fuels (HPFs) created from novel cycloalkanes as well as molecules found in existing jet fuels.

Motivation

- Jet fuel totaled ~24% of total operating cost for airlines globally in 2018[1]
- Aircraft account for ~9% of US transportation-related greenhouse gas emissions[2]

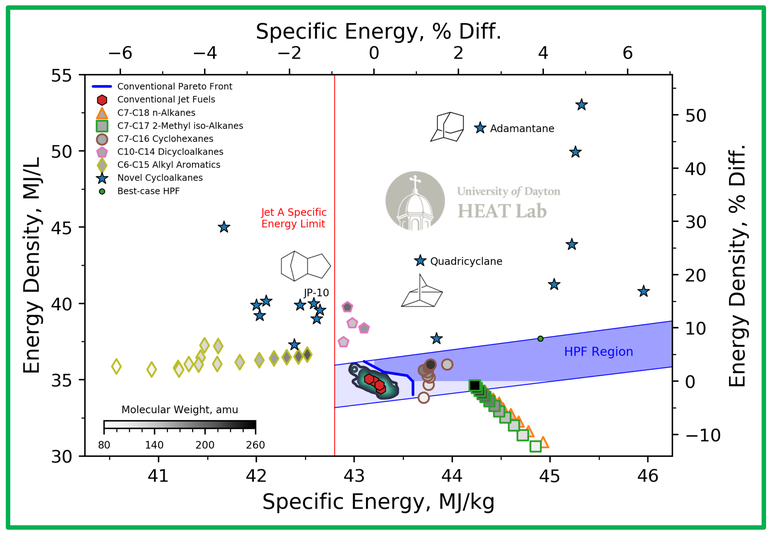


Mapping this project onto the UN Sustainable Development Goals[3]

- **7.A** Facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology.
- **15.B** Finance sustainable forest management... including for conservation and reforestation.

Methodology

- Use the Jet Fuel Blend Optimizer (JudO) to identify blends of novel cycloalkanes and conventional molecules that meet HPF criteria
- Quantify HPF benefits for aircraft via flight simulation software

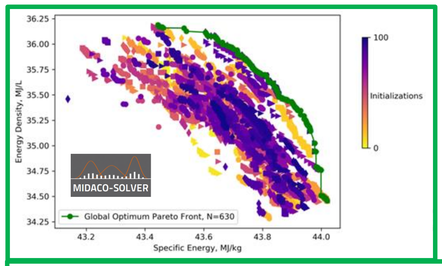


Specific energy plotted against energy density, providing insight into two key jet fuel performance properties. Cyclohexanes are the only molecular group that is potentially drop-in ready.

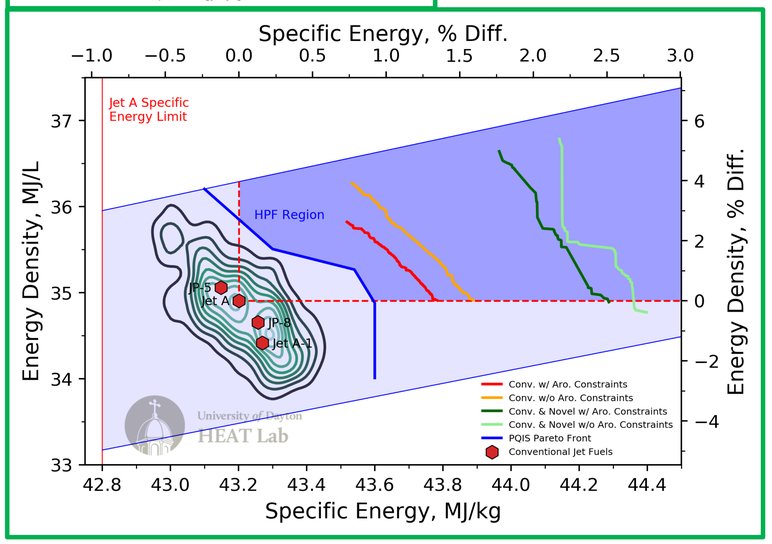
References

1. “Fuel Fact Sheet”, International Air Transport Association, 2018
2. “Inventory of U.S. Greenhouse Gas Emissions and Sinks”, Environmental Protection Agency, 2019
3. “Sustainable Development Goals Knowledge Platform”, United Nations, 2016

Results



Attainment of a global Pareto front using JudO software with 100 initial guesses.



JudO results for four different optimization scenarios. Removing aromatics improves performance and decreases sooting tendency.

Conclusions & Next Steps

- Optimization shows that cyclohexanes can significantly improve fuel performance and decrease sooting
- Best-case HPF break-even prices range from +4.6% to +10.0% relative to Jet A
- Addition of DCN, low temperature viscosity, and O-ring swelling constraints